2

UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF WISCONSIN

BRIGGS & STRATTON CORPORATION,

Plaintiff,

vs.

KOHLER CO.,

Defendant.

Case No.

JURY TRIAL DEMANDED

05 C 0025 C

COMPLAINT

The plaintiff, Briggs & Stratton Corporation, by its attorneys Michael, Best & Friedrich, LLP, for its complaint against Kohler Co., alleges as follows:

PARTIES

1. Plaintiff Briggs & Stratton Corporation (hereinafter, "Briggs & Stratton") is a corporation incorporated under the laws of the State of Wisconsin, having its principal place of business at 12301 West Wirth Street, Wauwatosa, Wisconsin 53222.

2. Defendant Kohler Co. (hereinafter, "Kohler") is a corporation incorporated under the laws of the State of Wisconsin, having a place of business at 444 Highland Drive, Kohler, Wisconsin 53044.

JURISDICTION AND VENUE

3. This action arises under the patent laws of the United States, Title 35, United States Code. This court has subject matter jurisdiction pursuant to 28 U.S.C. §§ 1338(a) and 1331.

4. Venue is proper in this judicial district pursuant to 28 U.S.C. §§ 1391(c) and 1400(b).

5. Kohler does substantial business in the State of Wisconsin and is subject to personal jurisdiction in the Western District of Wisconsin.

GENERAL ALLEGATIONS

6. On May 7, 2002, United States Patent No. 6,382,166 (the "166 patent") was duly and legally issued to Daniel L. Klika and John H. Thiermann for an invention entitled BALANCING SYSTEM USING RECIPROCATING COUNTERBALANCE WEIGHT. A copy of the '166 patent is attached hereto as Exhibit A and incorporated by reference.

7. On October 8, 2002, United States Patent No. 6,460,502 (the "502 patent") was duly and legally issued to Gary J. Gracyalny for an invention entitled ENGINE CYLINDER HEAD ASSEMBLY. A copy of the '502 patent is attached hereto as Exhibit B and incorporated by reference.

8. By virtue of assignment, Briggs & Stratton has acquired and continues to maintain all right, title and interest in and to the '166 and '502 patents.

CLAIM 1

9. Paragraphs 1 through 8 are realleged as though fully set forth herein.

10. Kohler, without the permission of Briggs & Stratton, has been, and still is, manufacturing, selling and offering for sale, within the United States, a single-cylinder internal combustion engine that infringes the '166 patent.

11. On information and belief, Kohler had actual notice of the '166 patent, and Kohler's infringement of the '166 patent has been and continues to be willful and deliberate.

CLAIM 2

12. Paragraphs 1 through 8 are realleged as though fully set forth herein.

13. Kohler, without the permission of Briggs & Stratton, has been, and still is,

manufacturing, selling and offering for sale, within the United States, a single-cylinder internal combustion engine that infringes the '502 patent.

14. On information and belief, Kohler had actual notice of the '502 patent and Kohler's infringement of the '502 patent has been and continues to be willful and deliberate.

WHEREFORE, plaintiff prays that:

1. Kohler be adjudged and decreed to have infringed United States Patent Nos. United States Patent No. 6,382,166;

2. Kohler be adjudged and decreed to have infringed United States Patent Nos. United States Patent No. 6,460,502;

3. A permanent injunction be issued restraining and enjoining Kohler, its officers, agents, attorneys and employees, and those acting in privity or concert with it, from making, using, selling, offering for sale or importing the infringing engines or engines that are no more than colorable variants thereof;

3. Kohler be ordered to pay damages adequate to compensate Briggs & Stratton for Kohler's infringement of the patents;

4. Kohler be ordered to account for and pay to Briggs & Stratton three (3) times Briggs & Stratton's actual damages by reason of Kohler's infringement of said patents, together with interest thereon;

5. This action be decreed an "exceptional case" within the meaning of 35 U.S.C. §285 and reasonable attorney fees be awarded to Briggs & Stratton;

6. Costs be awarded to Briggs & Stratton; and

7. Briggs & Stratton be granted such other and further relief as may be proper under the circumstances.

Dated this 13th day of January, 2005.

MICHAEL BEST & FRIEDRICH, LLP

By: ______________________________

David L. DeBruin,
Charles J. Crueger,
100 East Wisconsin Avenue
Suite 3300
Milwaukee, WI 53202-4108

Attorneys for Plaintiff
Briggs & Stratton Corporation

JURY DEMAND

The plaintiff Briggs & Stratton Company hereby demands a trial by jury of all issues triable of right by jury.

Dated this 13th day of January, 2005.

MICHAEL BEST & FRIEDRICH, LLP

By: ____________________________

David L. DeBruin, SBN 1013776
Charles J. Crueger, SBN 1029825
100 East Wisconsin Avenue
Suite 3300
Milwaukee, WI 53202-4108

Attorneys for Plaintiff
Briggs & Stratton Corporation

T:\clienta\018367\9932\A1038855.1

US006382166B1

(12) **United States Patent**
Klika et al.

(10) **Patent No.: US 6,382,166 B1**
(45) **Date of Patent: May 7, 2002**

(54) **BALANCING SYSTEM USING RECIPROCATING COUNTERBALANCE WEIGHT**

(75) Inventors: **Daniel L. Klika**, Waukesha; **John H. Thiermann**, Greenfield, both of WI (US)

(73) Assignee: **Briggs & Stratton Corporation**, Milwaukee, WI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/772,835**

(22) Filed: **Jan. 30, 2001**

(51) **Int. Cl.**[7] **F02B 75/06**
(52) **U.S. Cl.** **123/192.2**; 74/603
(58) **Field of Search** 123/192.2; 74/603

(56) **References Cited**

U.S. PATENT DOCUMENTS

350,068 A		9/1886	Louque	
1,738,876 A		12/1929	Edwards et al.	
1,871,899 A		8/1932	Marshall	
3,457,804 A		7/1969	Harkness	
4,407,169 A		10/1983	Menen	
4,440,123 A		4/1984	Tsai	
4,509,474 A		4/1985	Schmuck	
4,628,876 A		12/1986	Fujikawa et al.	
4,656,981 A		4/1987	Murata et al.	
4,688,528 A		8/1987	Nivi et al.	
4,781,156 A		11/1988	Berger et al.	
4,800,852 A		1/1989	Kandler	
4,819,593 A		4/1989	Bruener et al.	
5,335,532 A	*	8/1994	Mueller et al.	72/450
5,588,407 A		12/1996	von Essen et al.	
5,927,242 A		7/1999	Kollock	

* cited by examiner

Primary Examiner—Tony M. Argenbright
Assistant Examiner—Katrina B. Harris
(74) *Attorney, Agent, or Firm*—Michael Best & Friedrich LLP

(57) **ABSTRACT**

An engine counterbalancing system has a counterbalance weight that reciprocates in a linear manner in opposition to piston movement. The counterbalance weight is preferably coupled to the crankshaft via two spaced link arms that engage two respective eccentrics of the crankshaft. The counterbalance weight is guided by one or more rails that are formed integrally on the inner surface of the crankcase housing.

13 Claims, 5 Drawing Sheets

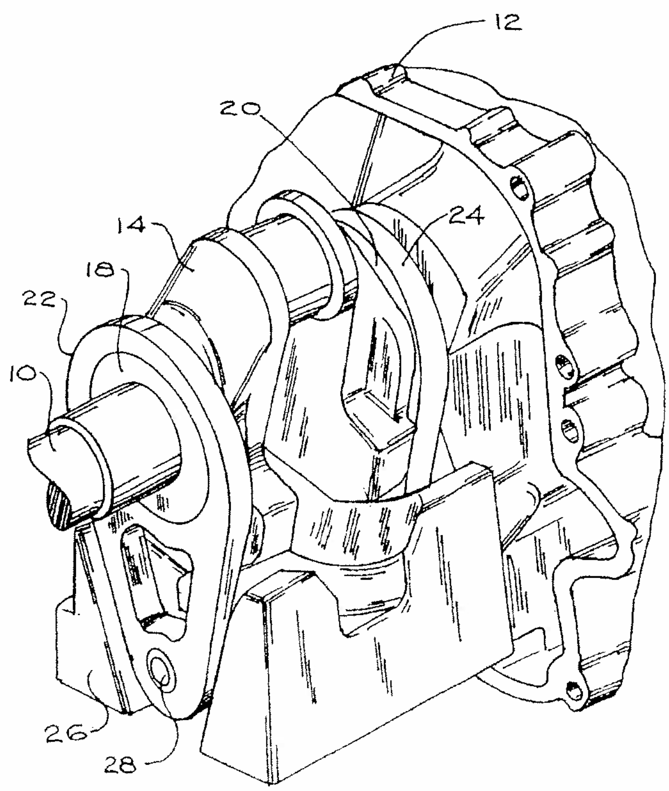


EXHIBIT
A

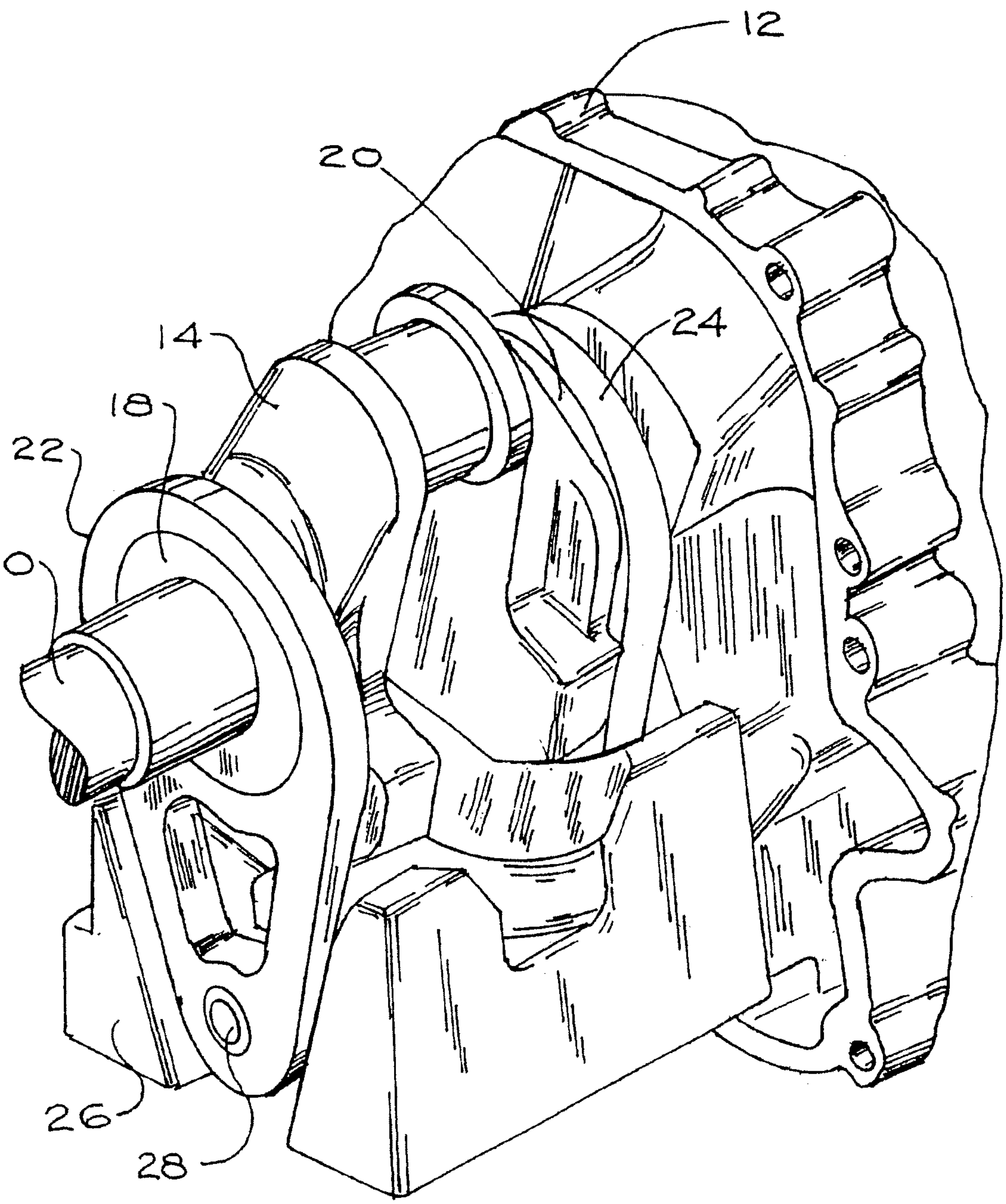


Fig. 1

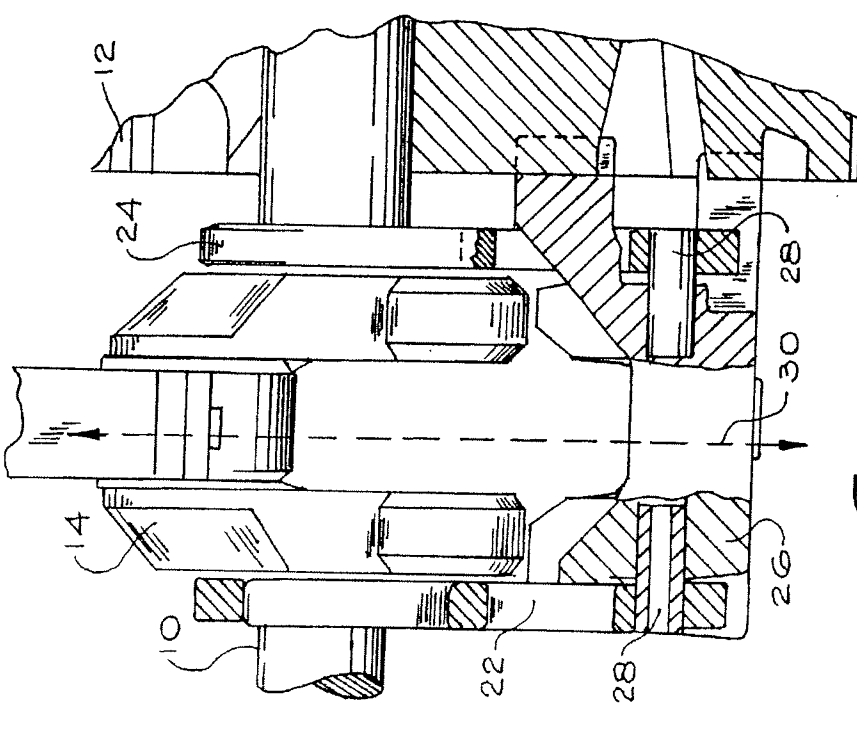


Fig. 2

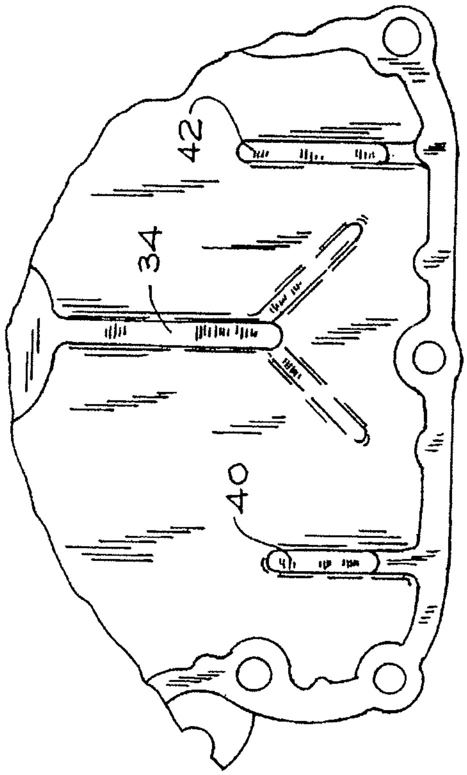


Fig. 3

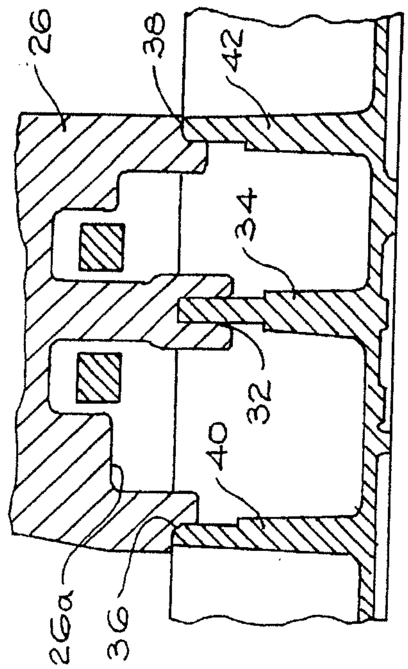


Fig. 4

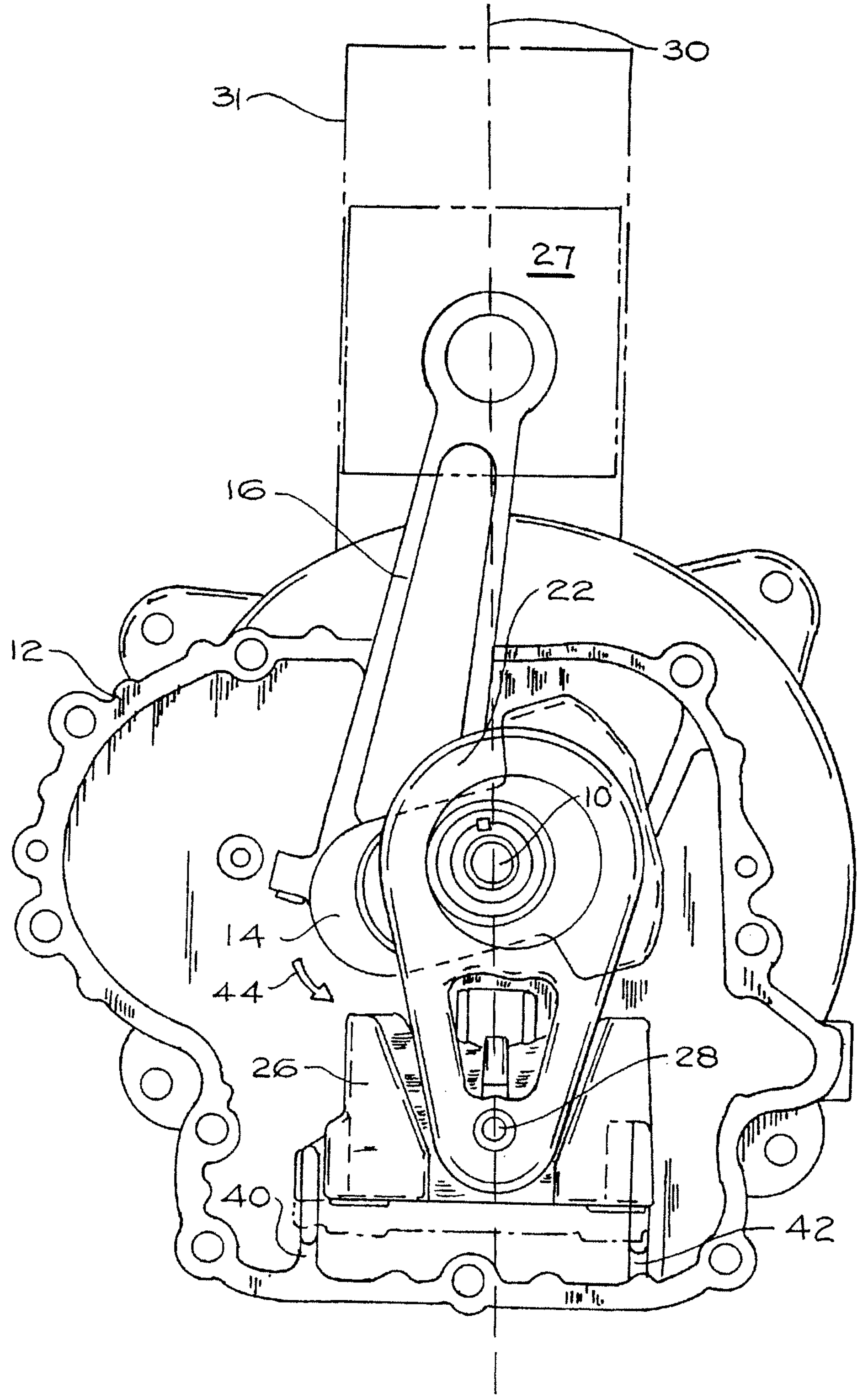


Fig. 5

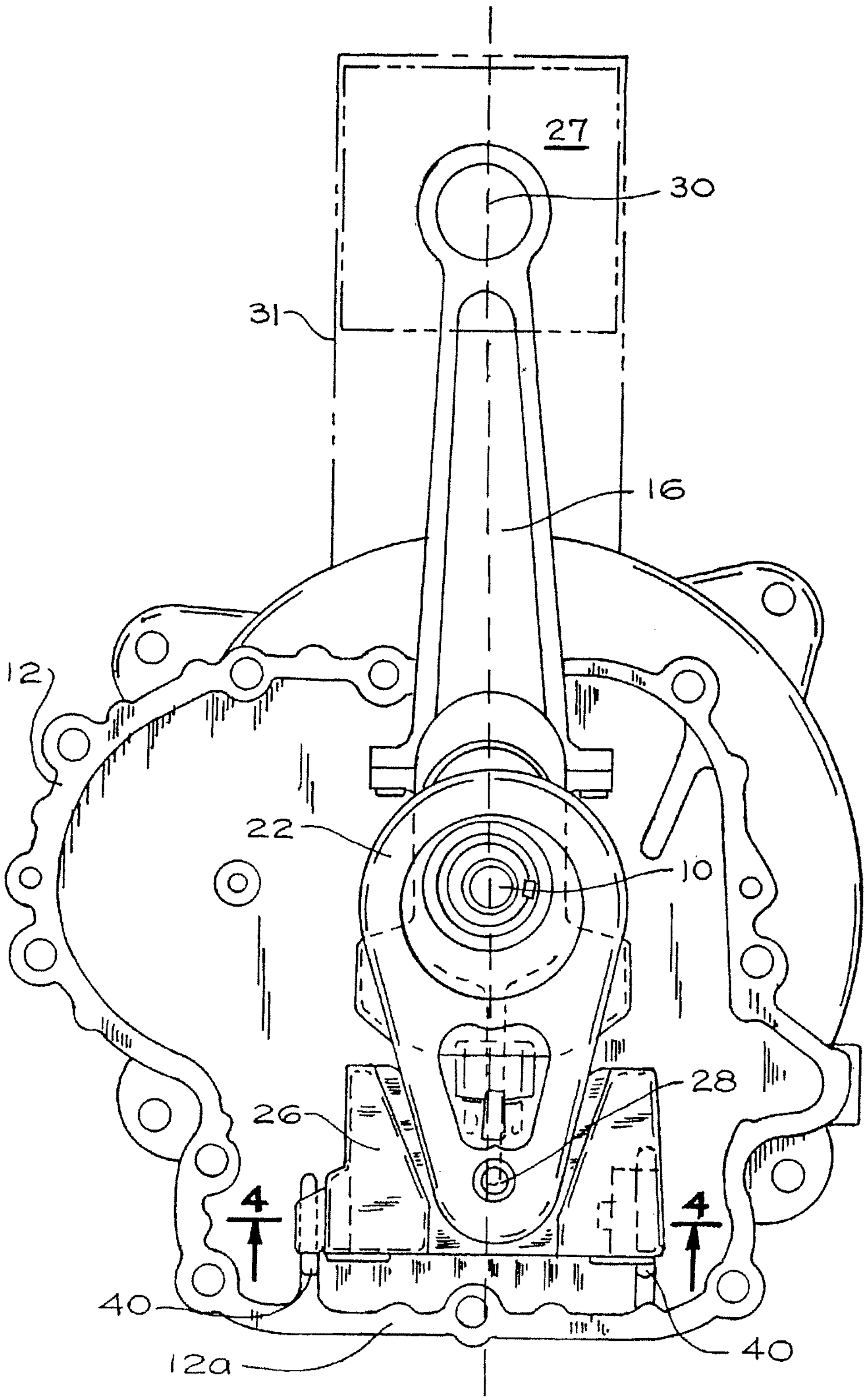


Fig. 6

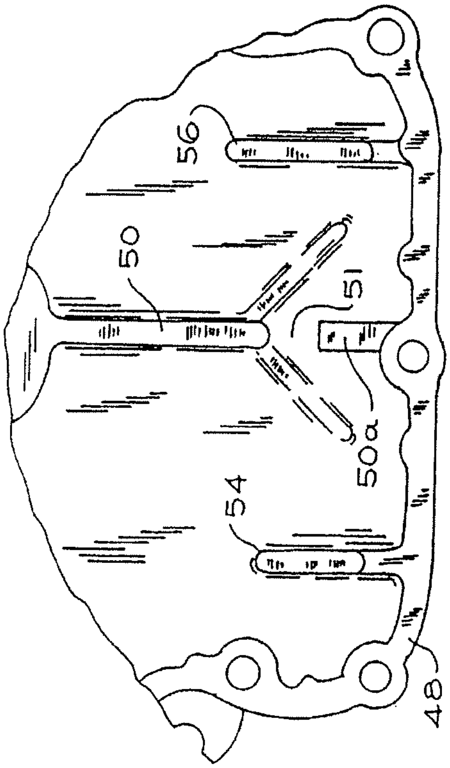


Fig. 8

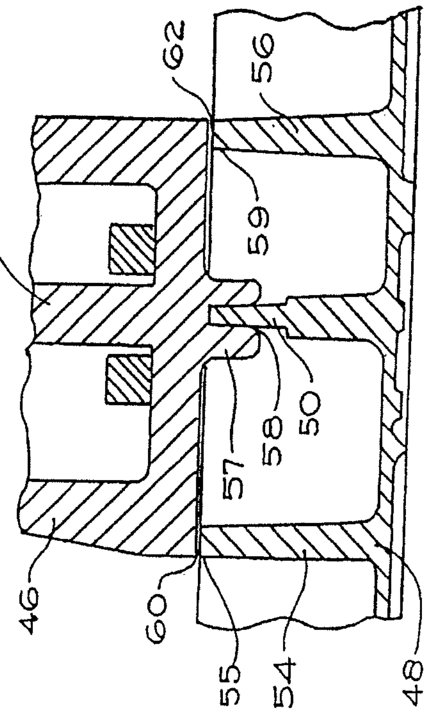


Fig. 9

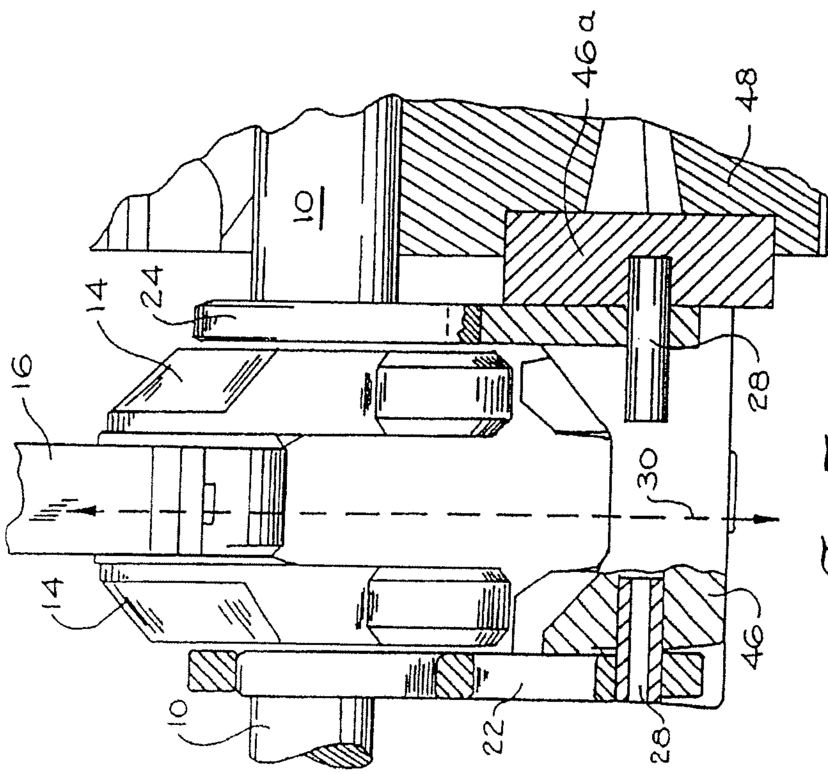


Fig. 7

BALANCING SYSTEM USING RECIPROCATING COUNTERBALANCE WEIGHT

FIELD OF THE INVENTION

The present invention relates generally to internal combustion engines, and more particularly to a reciprocating counterbalance weight for balancing such an engine.

BACKGROUND OF THE INVENTION

This invention relates to a counterbalance weight system for reducing the vibrational forces in an engine resulting from piston reciprocation.

A major cause of vibration in an engine is piston reciprocation. The piston is started and stopped twice during each rotation of the crankshaft, and reactions to the forces which accelerate and decelerate the piston are imposed upon the engine body as vibration in directions generally parallel to the piston axis. In installations such as lawn and garden implements, the engine produces a vibration that is transmitted through the machine to the operator. This vibration is uncomfortable and could produce operator fatigue. Even in an installation where there is no element of operator fatigue, such as sump pumps or portable generators, engine vibration is undesirable because it causes maintenance problems and tends to reduce the useful life of the machine.

To some extent such vibrations can be decreased by providing the engine with a counterweight fixed on its crankshaft, and located at the side of the crankshaft axis directly opposite the crankpin by which the piston, through the connecting rod, is connected to the crankshaft. More commonly, two counterweights may be used on the crankshaft, one located on each side of the piston axis. In either case, such a crankshaft counterweight arrangement produces a net resultant force vector that is diametrically opposite to the crankpin.

It is also known to use an additional counterbalance weight to further balance the forces due to piston reciprocation. Various arrangements are known for such counterbalance weights, including the use of pivoting and reciprocating counterbalance weights.

SUMMARY OF THE INVENTION

An engine balancing system is disclosed in which the counterbalance weight moves in a linear manner in opposition to the reciprocating piston.

In a preferred embodiment, the balancing system includes a counterbalance weight that is disposed on a second side of the crankshaft that is generally opposite to the first side on which the piston is disposed. The counterbalance weight reciprocates in response to rotation of the crankshaft. The invention further comprises an eccentric formed on the crankshaft, and at least one link arm that couples the counterbalance weight to the crankshaft. In the preferred embodiment, two spaced link arms are used.

The invention also includes at least one rail interconnected with the crankcase housing such that the counterbalance weight is slidable along the rail. One or two additional rails may be provided. Recesses or slots may be provided in the counterbalance weight that receive one or more rails. In an alternating embodiment, one or more rails may be provided, in addition to guides which keep the counterbalance weight in proper alignment, but are not themselves received within the counterbalance weight slots.

An advantage of the present invention is that the counterbalance weight moves in a linear manner in opposition to the linear motion of the reciprocating piston, for improved balancing.

Other features and advantages of the present invention would be apparent to those skilled in the art from the detailed description of the invention and the drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a balancing system according to the present invention.

FIG. **2** is a partial side view of the balancing system of FIG. **1**.

FIG. **3** is the top view of an engine crankcase housing depicting the rails and guides used in the present invention.

FIG. **4** is a cross sectional side view, taken along line **4—4** of FIG. **6**, depicting the rails engaging the slots on the counterbalance weight.

FIG. **5** is an end view of an engine when the piston is approaching the bottom dead center position.

FIG. **6** is an end view of the engine when the piston is at its top dead center position.

FIG. **7** is a partial side view of an alternate embodiment of a balancing system.

FIG. **8** is the top view of an engine crankcase housing depicting the rails and guides used in the alternate embodiment.

FIG. **9** is a cross sectional side view depicting the rails engaging the slots on the counterbalance weight of the alternate embodiment.

Before one embodiment of the invention is explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangements of the components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced or being carried out in various ways. Also, it is understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting. The use of "including" and "comprising" and variations thereof herein is meant to encompass the items listed thereafter and equivalents thereof as well as additional items.

DETAIL DESCRIPTION OF THE INVENTION

FIG. 1 is a perspective view of the invention incorporated into an engine.

In FIG. **1**, a crankshaft **10** is journaled in a crankcase housing **12**. The crankshaft has a throw **14** through which the crankshaft **10** engages a connecting rod **16** (FIG. **5**). The crankshaft also has two eccentrics **18** and **20** disposed on opposite sides of throw **14**. Respective link arms **22** and **24** are coupled between the respective eccentrics and a counterbalance weight **26**. Link arms **22** and **24** are preferably made from an aluminum alloy, which keeps the side to side forces lower than if the link arms are made from iron. Counterbalance weight **26** has two opposed pins **28** to which the link arms **22** and **24** are connected.

Counterbalance weight **26** may have any configuration, as long its mass is substantially evenly distributed on opposite sides of a cylinder axis **30** of cylinder **31** (FIG. **2**).

As best shown in FIGS. **3** and **4**, counterbalance weight **26** has a centrally disposed slot **32** in its crankcase facing surface **26***a* that receives a rail **34** interconnected with crankcase housing **12**. Counterbalance weight **26** also has two slots or recesses **36** and **38** in which ride two respective rails **40** and **42**. Rails **40** and **42** are also interconnected or formed integral with crankcase housing **12**.

In alternate embodiments, recesses **36** and **38** may be eliminated and replaced by flat surfaces which merely guide counterbalance weight during its reciprocation. In another alternative, recesses **36** and **38** may be replaced by slots similar to slot **32**, with slot **32** and rail **34** being eliminated.

In short, only a single rail is required with a corresponding slot or recess to guide the weight **26**, although it may be desirable to include one or more flat guide surfaces on both weight **26** and on the crankcase housing if only a single rail is used.

Of course, the rail could alternately be formed on weight **26** and the slot or recess formed integral or otherwise interconnected with the crankcase housing.

The position of the rails keeps them at least partially immersed in the crankcase oil, thereby keeping the rails and the corresponding slots well lubricated.

As best shown in FIGS. **5** and **6**, counterbalance weight **26** moves in a linear manner in opposition to the movement of piston reciprocation, thereby balancing the forces of the reciprocating piston.

FIG. **5** depicts the position of counterbalance weight **26** when the piston **27** is nearing its bottom dead center (BDC) position. In FIG. **5**, as the piston moves downward towards BDC, the crankshaft is rotating in the direction indicated by arrow **44**. At the same time, counterbalance weight **26** is reciprocating, moving in a linear direction toward crankshaft **10**, along rails **34**, **40** and **42**.

FIG. **6** depicts the piston **27** in its top dead center position. In this position, counterbalance weight **26** is at the position that is furthest away from crankshaft **10** and closest to the inner wall **12**a of crankcase housing **12**.

FIGS. **7** through **9** relate to a second embodiment of the invention having a single rail. In all the figures, like components have been given the same numerical designations.

In FIG. **7**, counterbalance weight **46** is guided by two link arms **22** and **24**, as in the first embodiment. However, link arm **24** is now positioned radially inward of counterbalance weight portion **46**a, to allow a longer, single rail to be used. By comparison, the embodiment shown in FIG. **2** has the link arm **24** positioned closer to the crankcase than in the second embodiment.

In FIGS. **7**–**9**, counterbalance weight **46** has an extension **57** in which a slot **58** is formed. An elongated, centrally-disposed rail **50** formed integral with crankcase **48** rides within slot **58**. The central rail **50** is divided into two sections **50** and **50***a* with a gap **51** therebetween. This gap enables lubricant to freely flow from one side of the rail to the other.

As also shown in FIGS. **8** and **9**, crankcase housing **48** has two spaced, integrally-formed guides **54** and **56** disposed on opposite sides of rail **50**, **50***a*. Guides **54** and **56** have flat upper surfaces **55**, **59** respectively which engage respective flat contact surfaces **60** and **62** of counterbalance weight **46**.

The entire balancing system may be assembled without the need for additional apertures being formed in the crankcase housing, thereby eliminating machining steps, keeping the part count low, and eliminating the gasket which would otherwise be used to seal an additional aperture. As a result, the cost and the likelihood of leaks is minimized.

The balancing system may be used on a wide variety of engines, including but not limited to single cylinder, vertical shaft overhead valve engines of the type used in lawn and garden applications.

We claim:

1. A balancing system for an internal combustion engine having a crankcase housing and a cylinder bore defining a cylinder axis, the system comprising:

a crankshaft substantially within the crankcase housing, wherein the cylinder bore is disposed on a first side of the crankshaft;

a piston disposed in the cylinder bore for reciprocal movement generally along the cylinder axis in response to rotation of the crankshaft;

a counterbalance weight disposed on a second side of the crankshaft that is generally opposite the first side, said counterbalance weight reciprocating in response to rotation of the crankshaft; and

a rail interconnected with at least one of said counterbalance weight and said crankcase housing such that said rail guides said counterbalance weight during reciprocation of said counterbalance weight.

2. The system of claim **1**, further comprising a link arm coupling the counterbalance weight to the crankshaft.

3. The system of claim **2**, further comprising a throw portion of the crankshaft, wherein the link arm engages the throw portion.

4. The system of claim **2**, further comprising an eccentric portion of the crankshaft, wherein the link arm engages the eccentric portion.

5. The system of claim **2**, wherein the link arm is formed from an aluminum alloy.

6. The system of claim **1**, further comprising two spaced link arms coupling the counterbalance weight to the crankshaft.

7. The system of claim **1**, further comprising a second rail interconnected with at least one of the counterbalance weight and the crankcase housing that guides said counterbalance weight.

8. The system of claim **7**, further comprising a third rail interconnected with at least one of the counterbalance weight and the crankcase housing that guides said counterbalance weight.

9. The system of claim **1**, wherein the rail is substantially parallel to the cylinder axis.

10. The system of claim **1**, wherein the other of said counterbalance weight and said crankcase housing has a slot that receives said rail.

11. The system of claim **1**, further comprising:

a guide surface that engages said counterbalance weight.

12. The system of claim **1**, wherein said counterbalance weight moves linearly in opposition to piston reciprocation.

13. The system of claim **1**, wherein the mass of said counterbalance weight is equally distributed on opposite sides of said cylinder axis.

* * * * *

US006460502B2

(12) United States Patent
Gracyalny

(10) Patent No.: US 6,460,502 B2
(45) Date of Patent: Oct. 8, 2002

(54) **ENGINE CYLINDER HEAD ASSEMBLY**

(75) Inventor: **Gary J. Gracyalny**, Milwaukee, WI (US)

(73) Assignee: **Briggs & Stratton Corporation**, Wauwatosa, WI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/792,256**

(22) Filed: **Feb. 24, 2001**

(65) **Prior Publication Data**

US 2002/0117143 A1 Aug. 29, 2002

(51) **Int. Cl.**[7] **F02F 1/00**
(52) **U.S. Cl.** **123/193.5**
(58) **Field of Search** 123/193.5, 184.21, 123/184.23

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,300,494 A * 11/1981 Graiff et al. 123/193.5
4,676,064 A * 6/1987 Narita et al. 123/193.5
6,026,774 A * 2/2000 Kajihara et al. 123/184.21

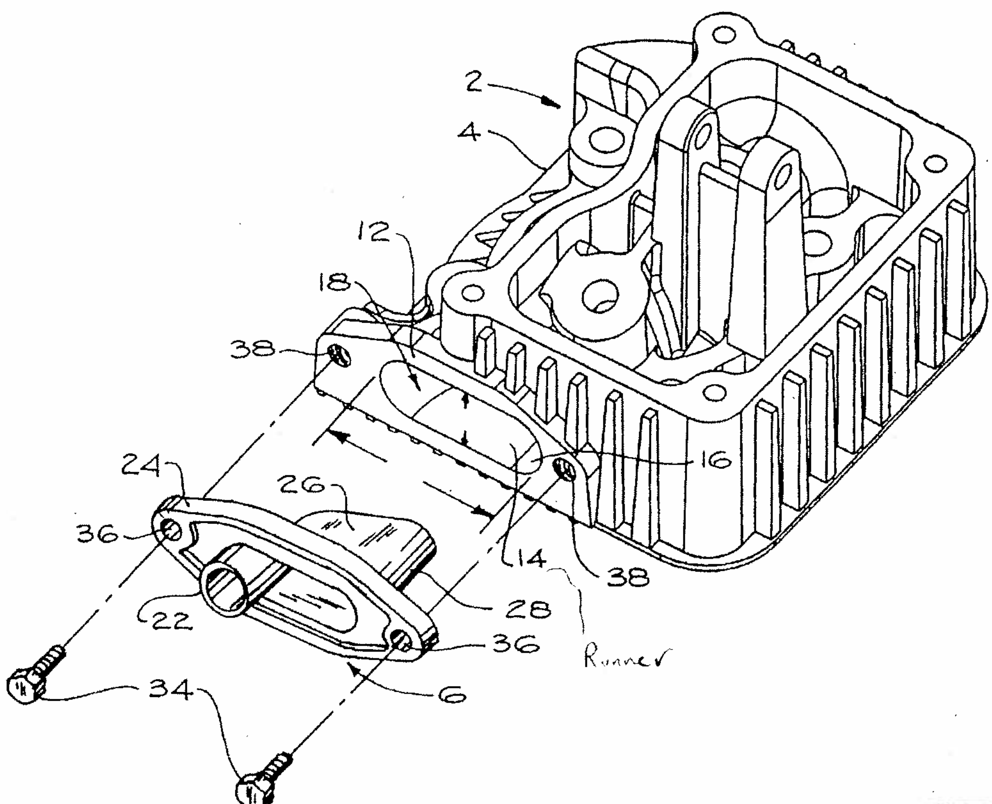
* cited by examiner

Primary Examiner—Marquerite McMahon
(74) *Attorney, Agent, or Firm*—Michael Best & Friedrich LLP

(57) **ABSTRACT**

A cylinder head assembly having a cylinder head and an adapter. The intake cavity of the cylinder head is relatively large, and the adapter fills a portion of the space in the cavity. The cylinder head has an intake runner that decreases in cross-sectional area as it progresses inward from the entrance to the intake port. The adapter has a runner filler that decreases in cross-sectional area as it extends away from a spacer, and is inserted into the intake runner. The volume of the runner filler is smaller than the volume of the intake runner, so a cavity is left within the intake runner. This cavity forms a portion of the intake passageway that leads from the carburetor to the cylinder. The position of the intake position may be altered to accommodate clearance problems with devices in which an engine is incorporated.

31 Claims, 10 Drawing Sheets



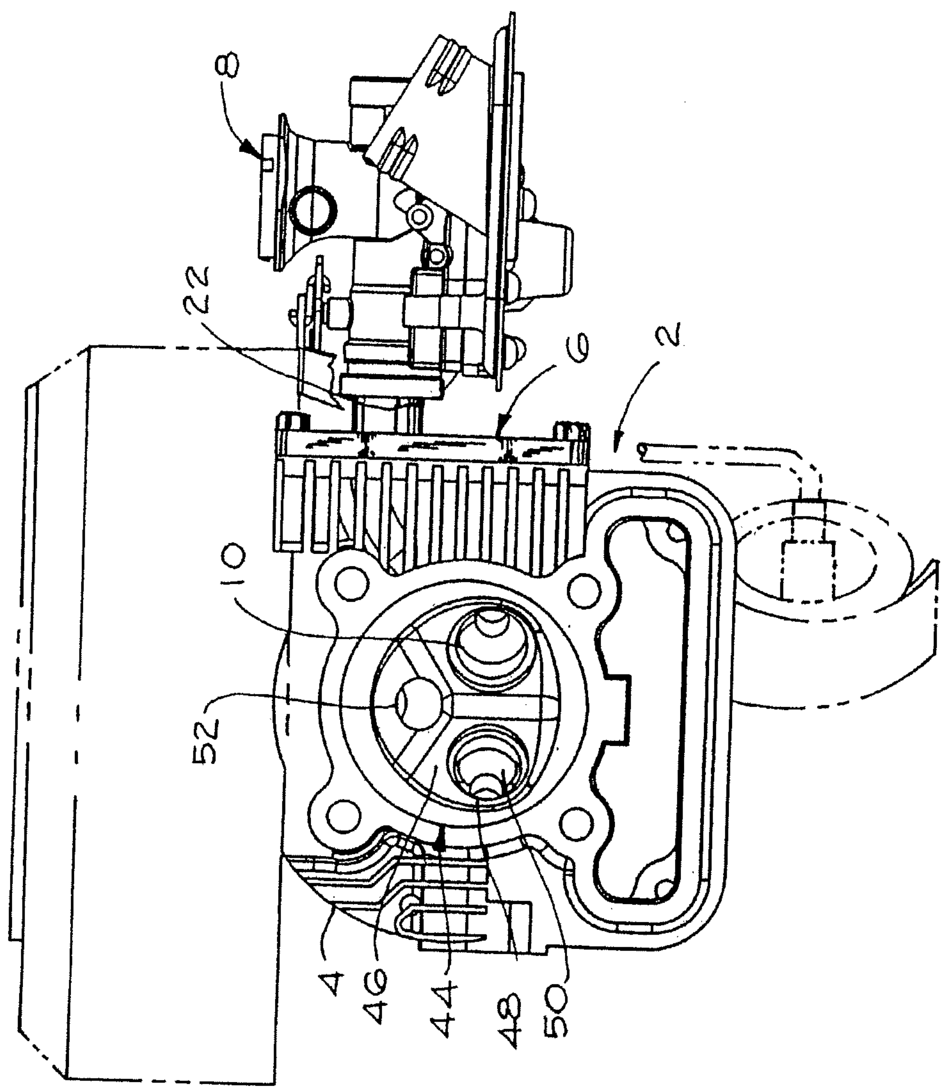


Fig 1

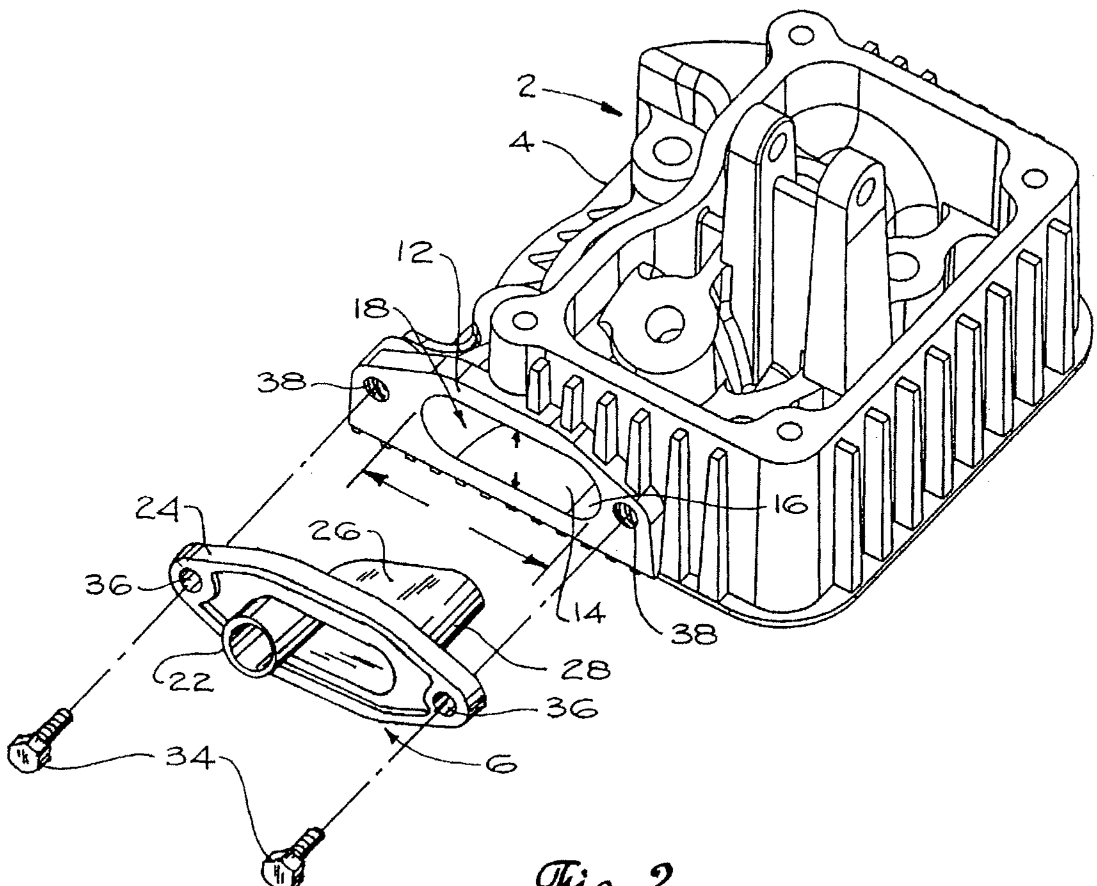


Fig. 2

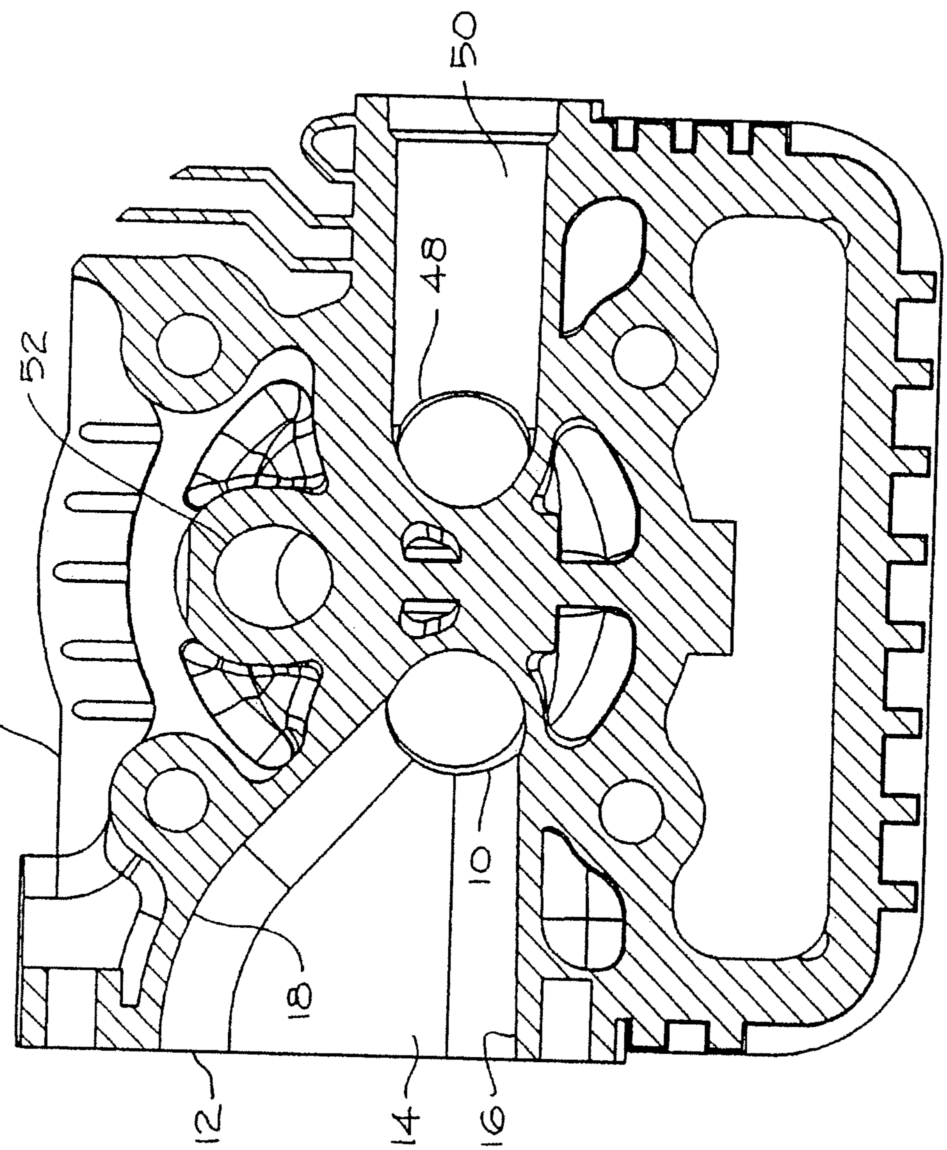


Fig 3

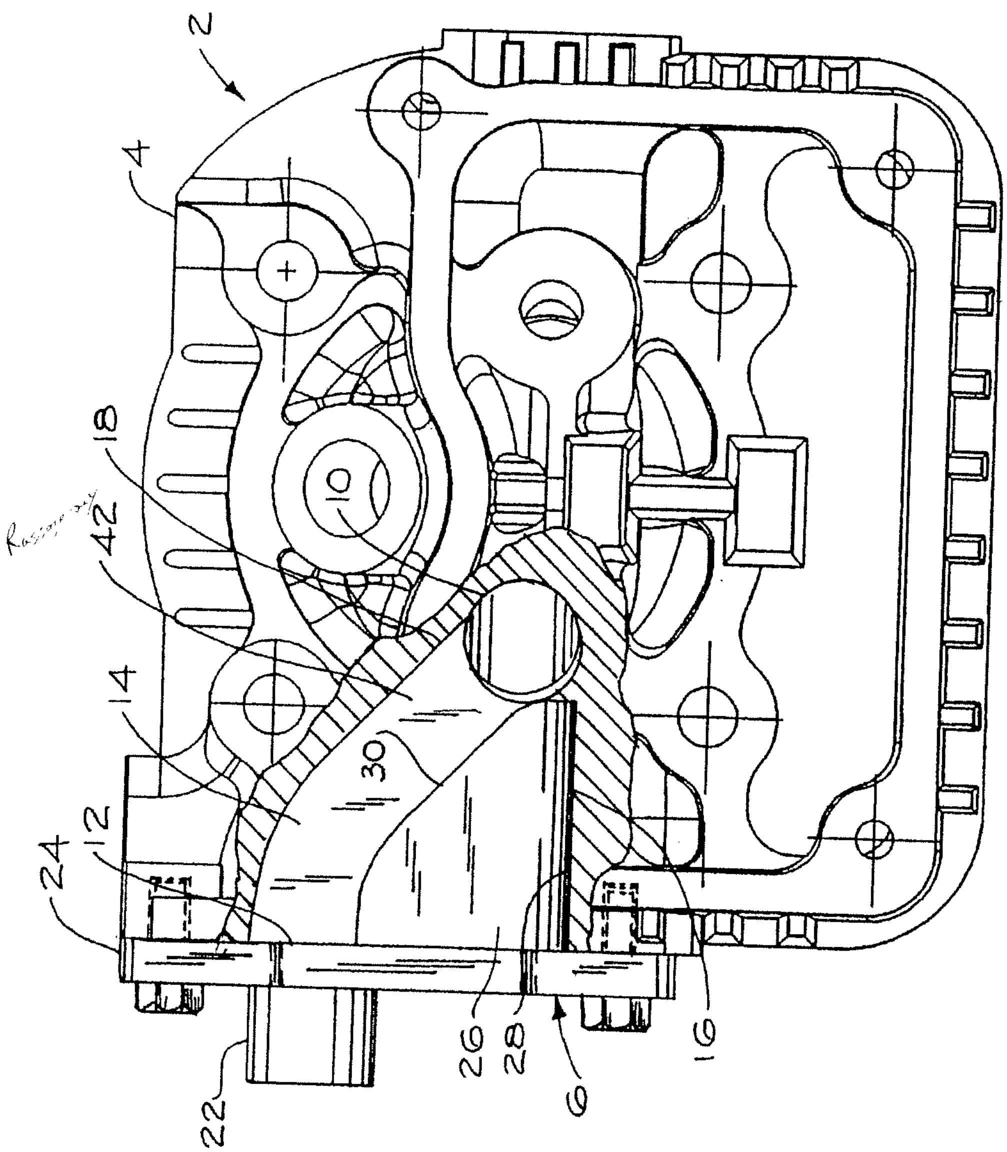


Fig 4

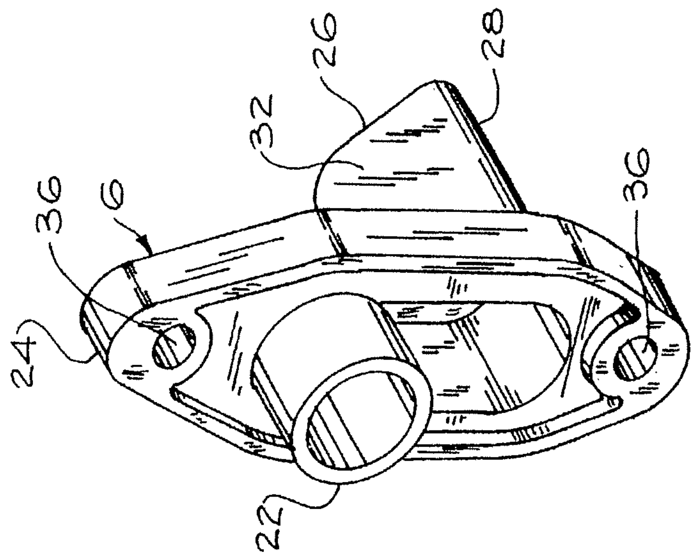


Fig 7

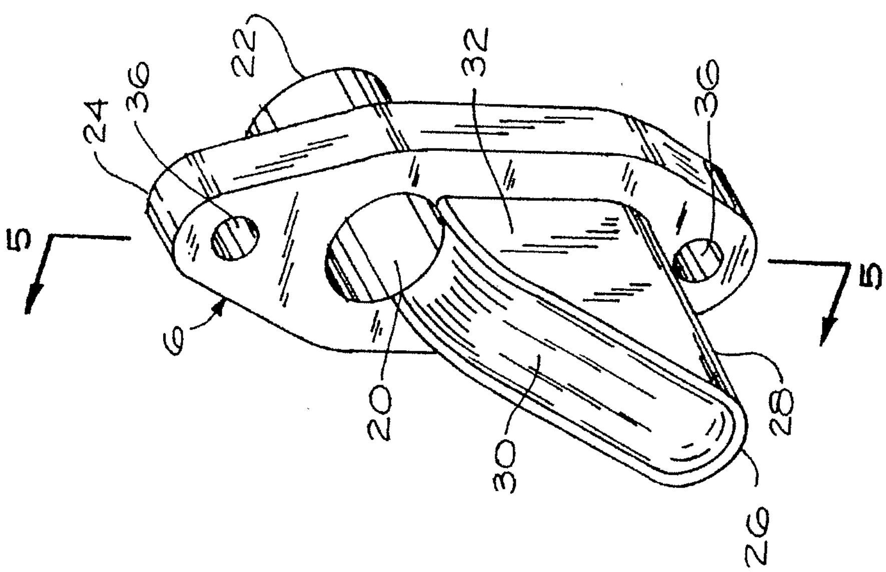


Fig 6

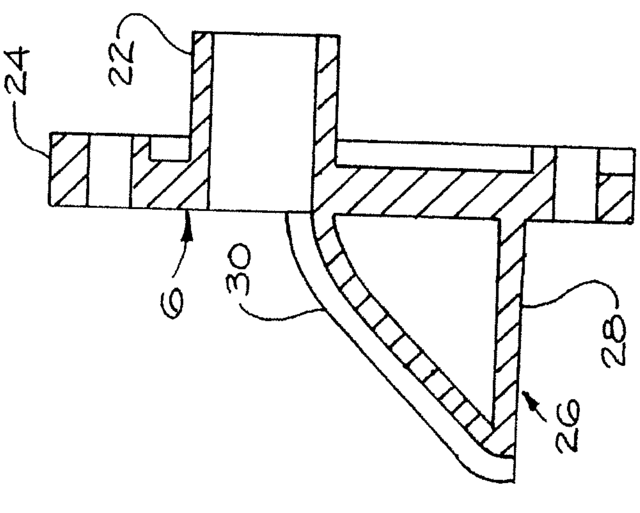


Fig 5

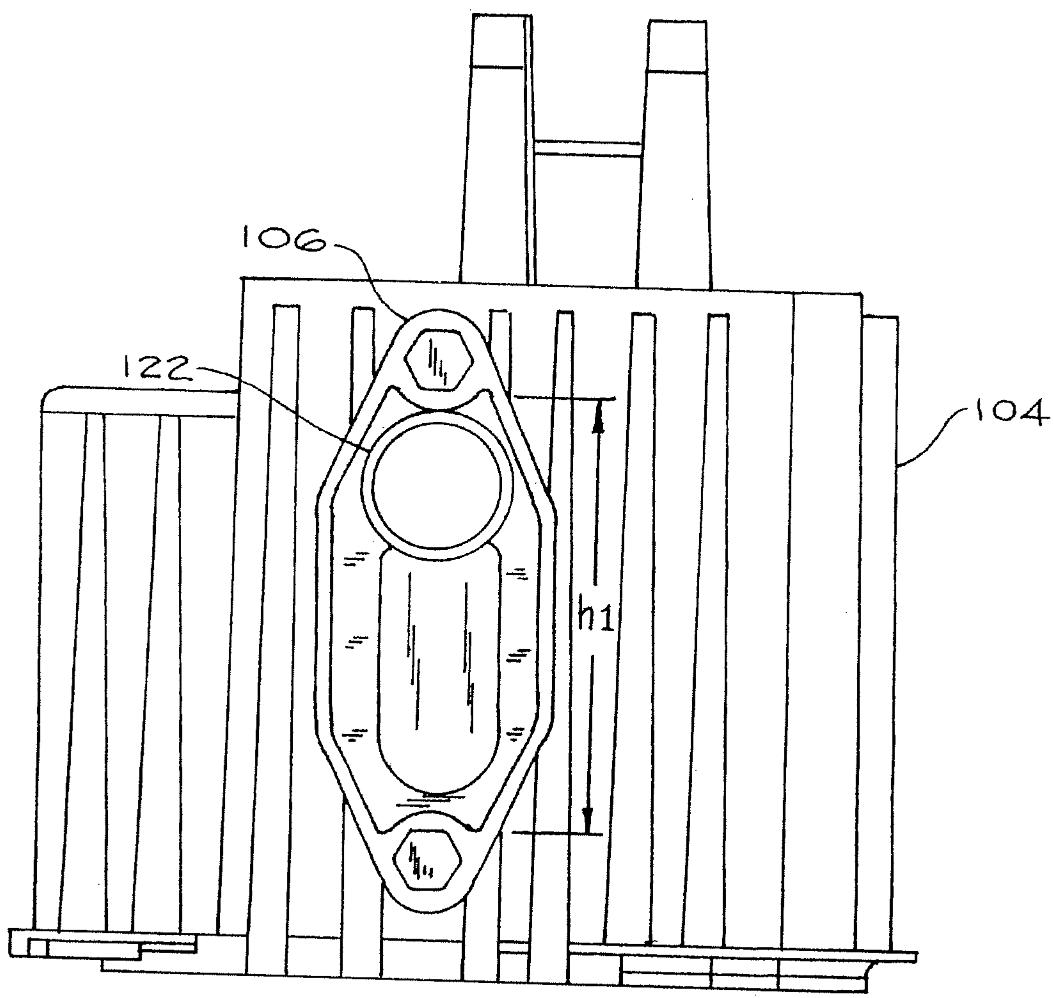


Fig. 8

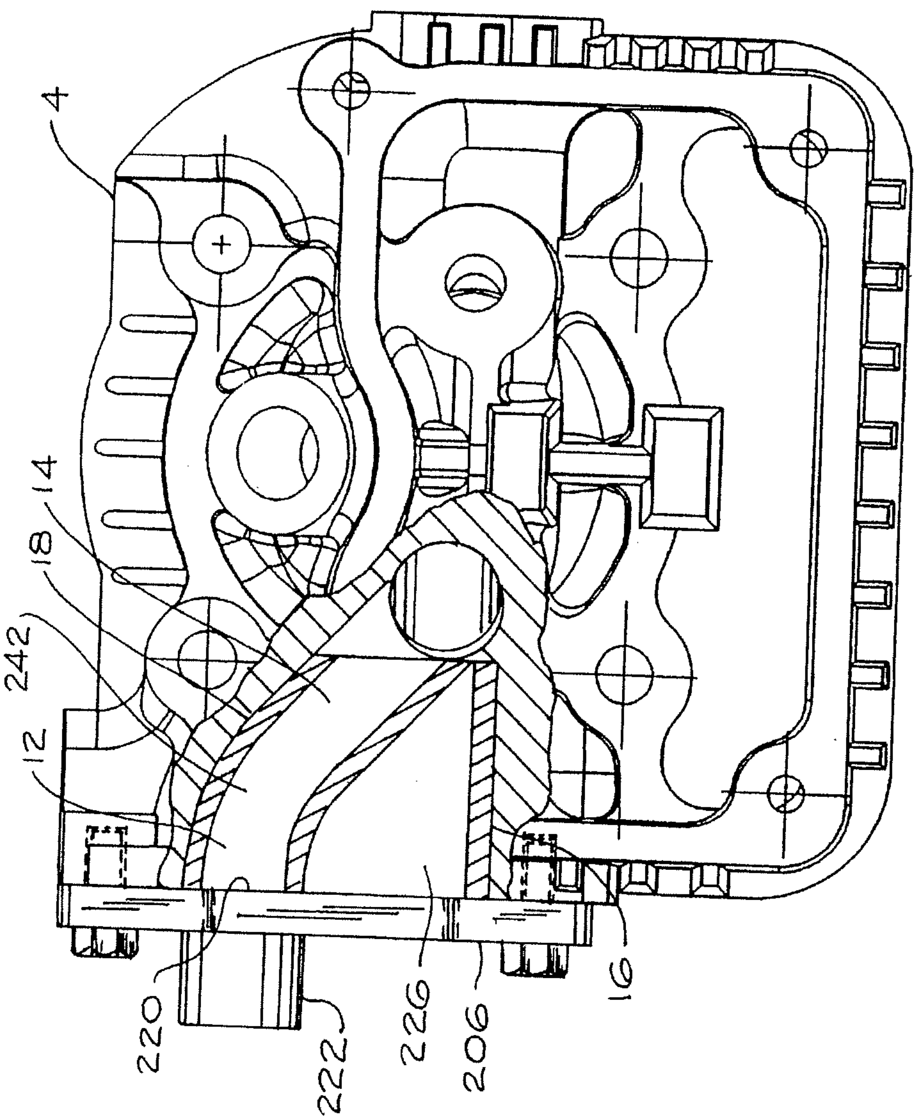


Fig. 9

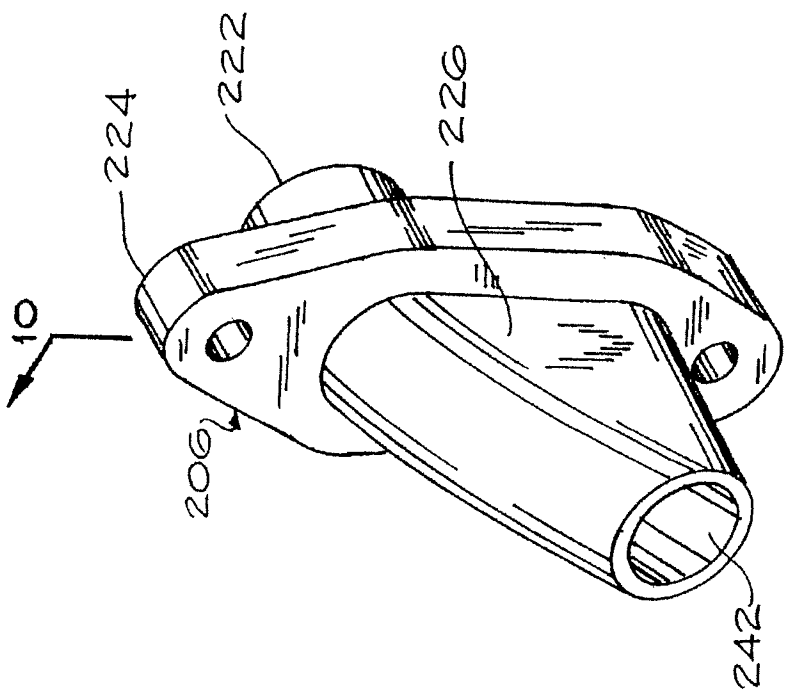


Fig. 11

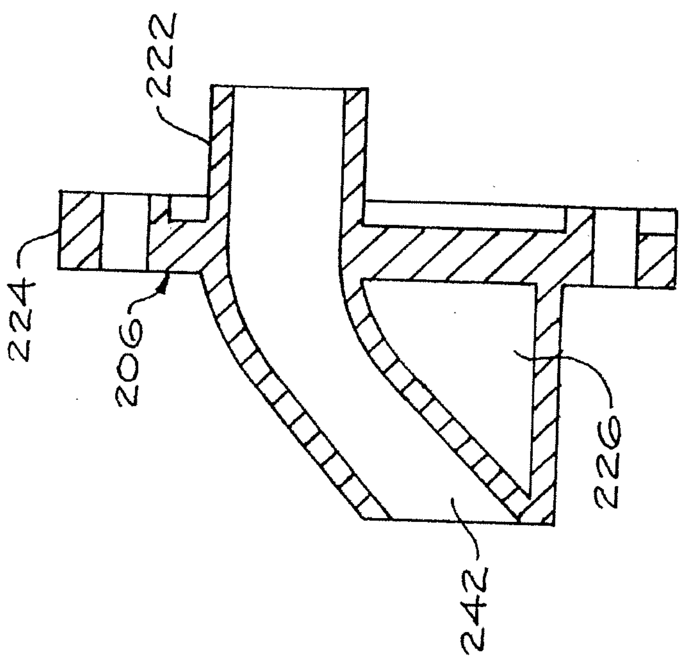


Fig. 10

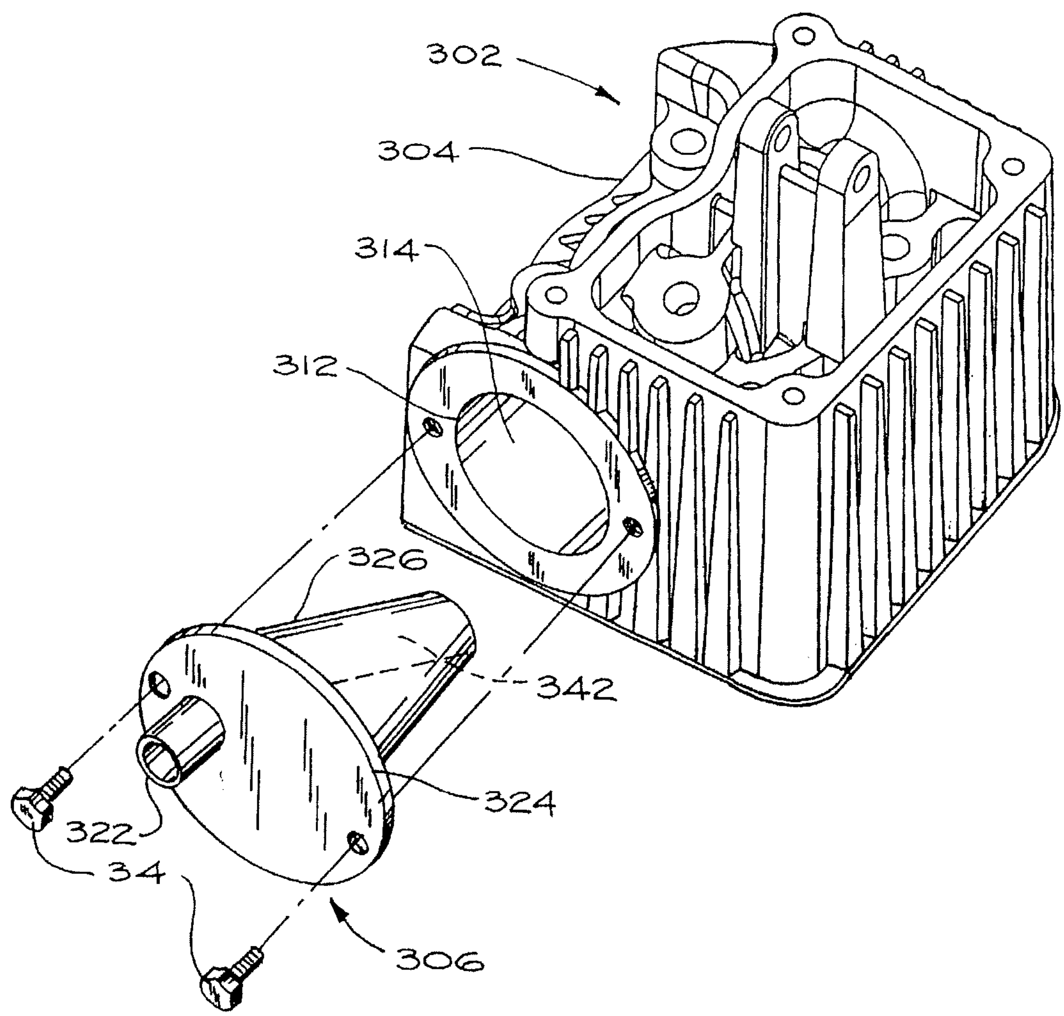


Fig.12

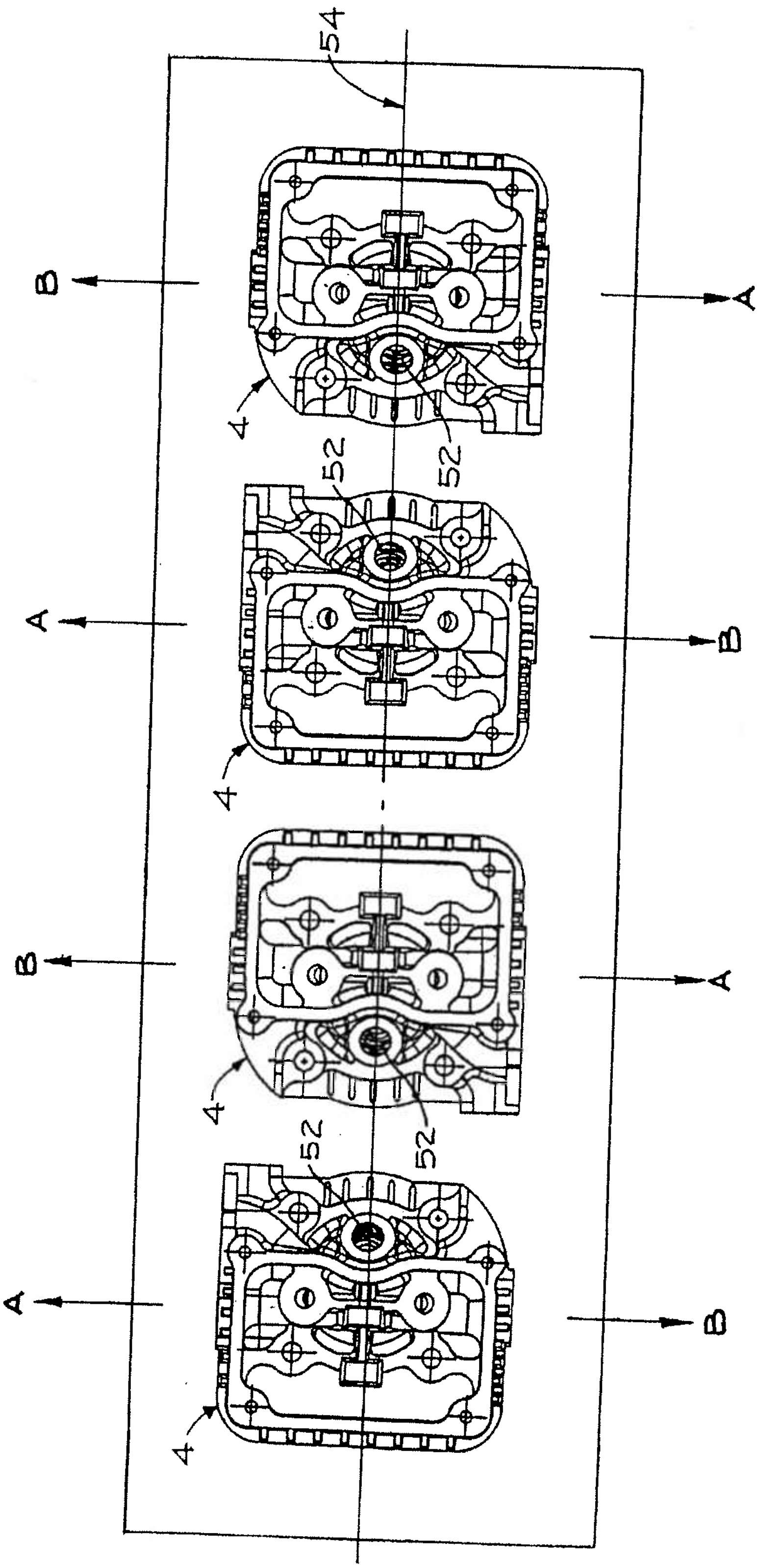


Fig 13

ENGINE CYLINDER HEAD ASSEMBLY

FIELD OF THE INVENTION

The present invention relates, generally, to internal combustion engines, and more particularly, to internal combustion engines used in snow blowers, generators, vegetation cutting devices such as lawn mowers, or other outdoor power equipment.

BACKGROUND OF THE INVENTION

Internal combustion engines are a common power source for various types of outdoor power equipment, such as lawn mowers or lawn tractors. In the engine industry, the engine manufacturer is usually different than the original equipment manufacturer ("OEM"). The engine manufacturer typically supplies engines to several different OEMs, all of which have different requirements for the location and placement of the engine. Redesigning engines to fit into confined spaces of existing OEM devices, such as lawn mowers or lawn tractors, significantly increases costs for the engine manufacturer. Thus, it is desirable for an engine manufacturer to have a flexible engine design and manufacturing method which can be easily modified to make engines that accommodate a variety of existing devices.

Cylinder heads for engines are commonly made using a die casting method. When die casting, it is cost effective to maximize the number of parts fabricated with each die tool, and to use simple, compact die tools. Therefore, the layout of the die tool is an important factor in designing a part. Die casting prior art cylinder heads often requires an intake runner core or insert that must be inserted diagonally ("diagonal slide") relative to the die opening direction. A diagonal slide can create a variety of parts, but it makes the tooling more complex and requires extra space and limits the number of parts each tool can make at the same time. Using straight slides, which move transverse to the die opening direction, restricts some prior art design options, but maximizes the efficiency of each die tool.

SUMMARY OF THE INVENTION

The present invention solves some of the problems of redesigning engines to fit existing OEM devices by forming an intake runner cavity that is relatively large, and then filling at least some of the cavity space with a runner filler to form and position the intake passageway as desired. The present invention allows the same die tool to make cylinder heads with different intake positions. The cylinder heads are also die cast using straight slides to maximize the number of parts made with each simple, compact die tool.

An important factor when an OEM selects an engine to use on a specific device is the location of certain engine parts, such as the intake position, mounting brackets, and drive shaft. An engine may not be compatible with an OEM device (e.g. a lawnmower deck) because existing features of the device interfere with parts of the engine. For example, there may not be enough room near the engine's intake position for a carburetor and fuel tank. This invention provides the flexibility to alter the intake position of an engine without redesigning the engine. This invention also enables a cylinder head incorporating the invention to be readily connected to a carburetor which would otherwise be at a different elevation than the intake passageway. Therefore, the engine can be used on a wider range of OEM devices.

The cylinder head assembly of the present invention includes a cylinder head and an adapter. The cylinder head has an entrance, an intake runner, and an intake port. The entrance is an opening on a side of the cylinder head. The intake runner, which connects the entrance to the intake port, decreases in cross-sectional area from the entrance to the intake port. The intake port is disposed between the intake runner and the combustion chamber.

The adapter is interconnected with the cylinder head and includes an inlet, a spacer, and a runner filler which is disposed within the intake runner. The inlet receives the air/fuel mixture from the carburetor. The spacer lies against the face of the cylinder head and acts as a thermal insulator for the carburetor. The runner filler is disposed within the cylinder head and at least partially forms the intake passageway that leads from the inlet to the intake port, and has a substantially uniform cross-sectional area.

In a preferred embodiment, the entrance is elliptical in cross-sectional shape. The intake runner cross-sectional area decreases between the elliptical entrance and the circular intake port. The adapter inlet is preferably a cylindrical opening that opens into the intake passageway. The runner filler is disposed within the intake runner, and at least part of the intake passageway surface is defined by the intake runner and runner filler. The crosssectional area of the intake passageway is substantially circular and substantially uniform.

In another embodiment, the entrance and intake runner can be of any shape. At the pentrance, the height dimension is larger than the width dimension. As the intake runner progresses from the entrance towards the intake port, the height dimension decreases until it is substantially the same as the width dimension.

In another embodiment, the entrance could be circular in cross-section, and the intake runner could be circular in cross-section at least near the entrance. The entrance could possibly be any shape, although an important factor is how the shape of the intake passageway affects the flow of the air/fuel mixture. The intake runner cross-sectional area could decrease in any manner, but again, an important factor is how the shape affects the air/fuel flow in the intake passageway.

In another embodiment of the present invention, at least a portion of the intake passageway is entirely enclosed within the runner filler. The runner filler completely defines at least a segment of the intake passageway between the inlet and the intake port. The intake runner may be any shape as long as the intake passageway maintains a substantially uniform cross-sectional area in the runner filler, and leading from the inlet to the intake port.

Another alternate embodiment of the present invention changes the orientation of the intake runner and adapter. In a preferred embodiment discussed above, a line containing the height dimension of the entrance is substantially transverse to a longitudinal axis of a piston cylinder. In this alternate embodiment, a line containing the height dimension of the entrance is substantially parallel to a longitudinal axis of a piston cylinder. The intake runner and adapter may also be oriented at any angle between those two locations.

In a carburetor engine, the air/fuel mixture is regulated by the carburetor, and anything that disrupts the air/fuel flow in the intake passageway of a carburetor engine may reduce engine efficiency by creating flow losses or by altering the air/fuel mixture.

The present invention provides a substantially straight and uniform passageway from the carburetor to the cylinder. This objective is achieved by altering the intake position while maintaining a relatively short and straight intake passageway.

The ability to alter the cylinder head's intake position allows the engine manufacturer to use existing engine designs for different OEM devices. This feature of the invention reduces costs for the engine manufacturer and OEMs and increases flexibility to adapt an engine to an OEM device.

Other features and advantages of the invention will become apparent to those skilled in the art upon review of the following detailed description, claims and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, wherein like reference numerals indicate like parts:

FIG. 1 is an end view of the cylinder head assembly and carburetor according to a preferred embodiment of the present invention;

FIG. 2 is an exploded view of the cylinder head assembly shown in FIG. 1, illustrating the adapter and the cylinder head;

FIG. 3 is a cross-sectional view of the cylinder head shown in FIG. 2, illustrating the intake runner;

FIG. 4 is a cross-sectional view of the cylinder head assembly shown in FIG. 2, illustrating the runner filler within the intake runner;

FIG. 5 is a cross-sectional view of the adapter;

FIG. 6 is a perspective view of the adapter shown in FIG. 2, illustrating the spacer and runner filler;

FIG. 7 is a perspective view of the adapter shown in FIG. 2, illustrating the spacer and inlet;

FIG. 8 is a side view of an alternate embodiment of the cylinder head with the position of the intake runner and adapter changed;

FIG. 9 is a cross-sectional view of the cylinder head assembly with the intake passageway at least partially enclosed within the runner filler.

FIG. 10 is a cross-sectional view of the adapter shown in FIG. 9;

FIG. 11 is a perspective view of the adapter in the alternate embodiment shown in FIG. 9, illustrating the spacer and runner filler;

FIG. 12 is a perspective view of an alternate embodiment of the cylinder head assembly; A

FIG. 13 is a schematic representation of four cylinder heads which are capable of being produced using one compact die tool and one die casting machine.

Before the embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangements of components set forth in the following description or illustrated in the drawings. The invention is capable of other embodiments and of being practiced or of being carried out in various ways. Also, it is to be understood that the phraseology and terminology used herein is for the purpose of description and should not be regarded as limiting.

DETAILED DESCRIPTION

A preferred embodiment of the cylinder head assembly **2** of the present invention is illustrated in FIG. **1** as it would appear in an engine. The present invention may be used with any conventional engine and cylinder head. One such cylinder head **4** is shown by way of example only in the figures. The cylinder head assembly **2** is typically connected to a conventional carburetor **8** and a cylinder **44**, and forms an end of a combustion chamber **46**. The carburetor **8** creates the proper air/fuel mixture and is connected to the adapter **6** at the inlet **22**. As shown in FIG. **4**, the air/fuel mixture proceeds into the inlet **22** and through the intake passageway **42**. In FIG. **1**, the air/fuel mixture then passes through the intake port **10** and into the combustion chamber **46** of the cylinder **44**. The cylinder head **4** also includes an exhaust port **48**, an exhaust passageway **50** and a spark plug hole **52**.

As illustrated in FIGS. **2** and **4**, the cylinder head assembly **2** includes a cylinder head **4** and an adapter **6**. The cylinder head **4**, as can best be seen in FIGS. **2** and **3**, includes an entrance **12**, an intake runner **14**, and an intake port **10**. Preferably, the entrance **12** has an elliptical shape and is on a side face of the cylinder head **4** (FIG. **2**). The entrance **12** has a height dimension (h) and a width dimension (w). In this preferred embodiment, a line containing the height dimension (h) is substantially transverse to a longitudinal axis of a piston cylinder. The intake runner **14** starts at the entrance **12**, and the cross-sectional area of the intake runner **14** preferably decreases as the intake runner **14** approaches the intake port **10**. As the intake runner **14** progresses from the entrance **12** to the intake port **10**, the height dimension (h) preferably decreases until it is approximately equal to the width dimension (w).

The intake runner **14** preferably has a straight side **16** and an inclined side **18**. The straight side **16** preferably has a surface of a segmented cylinder. The inclined side **18** preferably has a semi-circular cross section and begins at the end of the entrance opposite the straight side **16**. The distance between the inclined side **18** and the straight side **16** preferably decreases as they approach the intake port **10**. The intake port **10** is disposed between intake runner **14** and the cylinder **44** (FIG. **1**), and permits the intake runner **14** to be in fluid flow communication with the cylinder **44** (FIG. **1**).

As shown in detail in FIGS. **5**, **6** and **7**, the adapter **6** includes an inlet **22**, spacer **24**, and runner filler **26**. One with ordinary skill in the art will recognize that the adapter **6** can be made out of several materials using various methods of manufacture. In the preferred embodiment, the adapter **6** is made of plastic using injection molding.

As illustrated in FIG. **7**, the inlet **22** is preferably an open cylindrical extension with a substantially circular cross-sectional area. The inlet **22** is preferably long enough to interconnect to the carburetor **8**.

In FIG. **6**, the cylindrical opening of the inlet **22** continues through the spacer **24** to from the spacer opening **20**. The surface of the spacer **24** with the runner filler **26** preferably lies against a face of the cylinder head **4**. The spacer **24** may be solid or hollow and the thickness may vary, as long as the spacer provides adequate thermal insulation for the carburetor **8**. The thickness of the spacer **24** in the preferred embodiment is approximately 0.35 inches.

The runner filler **26** preferably has two side surfaces **32**, a contact surface **28**, and a passage surface **30**. Preferably, the contact surface **28** has the shape of a segmented cylinder and extends substantially normal from the spacer **24**. The passage surface **30** preferably has a semi-circular cross-section and intersects the contact surface **28** at the end of the runner filler **26**. When viewed from the side, as in FIG. **5**, the runner filler **26** in the preferred embodiment has a substantially triangular profile. Preferably, the edges of the passage surface **30** have a slight radius near the spacer **24** and near the end of the runner filler **26**. These slight curves smooth the change in direction of the intake passageway **42** (FIG. **4**).

In an alternate embodiment, the side profile of the runner filler 26, as viewed similar to FIG. 5, could be a quarter circle shape, or any other similar shape, as long as the cross-sectional area of the intake passageway 42 (FIG. 4) remains substantially uniform.

As illustrated in FIG. 2, the adapter 6 is preferably fastened to the cylinder head 4 with bolts 34 that pass through the bolt apertures 36 and into the threaded apertures 38. One skilled in the art will recognize that any suitable fasteners may be used to attach the adapter 6 to the cylinder head 4.

As shown in FIG. 4, the runner filler 26 is at least partially disposed within the intake runner 14 and decreases in cross-sectional area as it extends away from the spacer 24. Together the inclined surface 18 and the passage surface 30 preferably define at least a 30 portion of the intake passageway 42. The intake passageway 42 is preferably a substantially tubular shaped conduit that extends from the inlet 22 to the intake port 10. Preferably, the intake passageway 42 has a substantially uniform cross-sectional area that is substantially the same size as the cross-sectional area of the inlet 22.

FIG. 8 shows an alternate embodiment where the intake runner and adapter 106 are oriented approximately 90 degrees from the position depicted in FIG. 2. In the embodiment in FIG. 8, a line containing the height dimension h1 of the entrance is substantially parallel to a longitudinal axis of a piston cylinder. The actual orientation of the intake runner and adapter 106 to the cylinder head 104 is not critical to the invention. This alternate embodiment allows more options when fitting engines to existing OEM devices, and generates different and improved intake flow characteristics. The angle at which the intake runner can be oriented is only limited by the constraints of the other features of the engine or OEM device which may interfere with the intake runner, such as valves guides, mounting holes, or carburetor or fuel tank location, as well as die construction.

Another alternate embodiment is shown in FIG. 9 where a section of the intake passageway 242 is completely enclosed within the runner filler 226. In this embodiment the runner filler 226,completely surrounds the spacer opening 220 and entirely defines at least a segment of the intake passageway 242. Only the adapter 206 must be changed to accommodate a slightly different intake position for the engine. Adapters with different intake positions can be used with cylinder heads 4 made with the same intake runner 14. The intake passageway 242 of a conventional cylinder head is usually completely defined by the cylinder head and positioned approximately where the straight side 16 is located in the present invention. In the preferred embodiment of this invention, the inlet 222 is positioned near the inclined side 18 of the intake runner 14. This alternate embodiment allows the inlet 222 to be positioned anywhere along the entrance 12. Changing the location of the inlet 222 and enclosing a portion of the intake passageway 242 within the runner filler 226 omits adapters with an inlet position along this entire range to be used with the same cylinder head 4.

FIGS. 10 and 11 illustrate the adapter 206 of this alternate embodiment in more detail. In FIG. 11, a section of the intake passageway 242 is completely enclosed within the runner filler 226. The entire length of the runner filler 226 encloses a portion of the intake passageway 242, however any length of an enclosed segment of the runner filler 226 would be possible. The inlet 22 could also be at any point along theadapter-206 such that the intake passageway 242 still passes through the entrance of the intake runner.

FIG. 12 illustrates another alternate embodiment of the cylinder head assembly 302. In this embodiment, the intake runner 314 and the runner filler 326 have a substantially circular cross-section. The cross-sectional area of the intake runner 314 preferably decreases as the intake runner 314 progresses inward from the entrance 312. The intake runner 314 and runner filler 326 may have a substantially conical shape. The intake passageway 342 may be enclosed by the runner filler 326. This embodiment allows the inlet 322 to be located at almost any point on the face of the spacer 324, as long as fluid losses are minimized and as long as the inlet 322 passes though the spacer 324 to intersect with the intake passageway 342 within the runner filler 326. Therefore, a greater range of intake potions are possible by only changing he adapter-306 and using the same cylinder head 304. Other variations are also possible with the cross-section of the intake runner 314 and runner 326 being any shape between an ellipse and circle.

FIG. 13 depicts a layout for the die used to manufacture cylinder heads 4 according to the present invention. The cylinder head 4 is preferably designed to permit four cylinder heads 4 to be produced using one compact die tool and one die casting machine. The cylinder head is designed to include walls which allow for the needed draft angles given different orientations for each cylinder head within the die tool. The draft angles enable the cylinder head 4 to readily separate from the die. The cylinder head 4 is preferably designed to permit slide tooling access (i.e., the intake runner and exhaust passageway) when four cylinder heads are fabricated from one tool.

In FIG. 13, the die is formed so that the spark plug holes 52 of corresponding cylinder heads 4 are adjacent to each other. The die is arranged so that the inserts which form the cavity of the intake runner 14 move in direction A, and the inserts which form the exhaust passageway 36 move in direction B. In a preferred embodiment, the die is positioned so that the directions A and B alternate in adjacent cylinder heads.

By positioning the cylinder heads 4 in the manner described, the inserts used to form the cylinder heads are moved only along two directions, i.e., in directions A and B. This die configuration reduces the overall space required to make the cylinder heads 4, while still enabling four cylinder heads 4 to be made at the same time.

The embodiments described above and illustrated in the drawings are presented by way of example only and are not intended as a limitation upon the concepts and principles of the present invention. As such, it will be appreciated by one having ordinary skill in the art that various changes in the elements and their configuration and arrangement are possible without departing from the spirit and scope of the present invention as set forth in the appended claims.

What is claimed:

1. A cylinder head assembly for an internal combustion engine comprising:

an intake port;

an intake runner that receives at least one of air and fuel, said intake runner including:

an entrance;

a section having a first end nearer said entrance and having a second end nearer said intake port;

an adapter having a runner filler disposed within said intake runner;

an intake passageway having a substantially uniform cross-sectional area created at least in part by said runner filler; and

wherein the cross-sectional area of said intake runner decreases from said entrance to said intake port.

2. A cylinder head assembly according to claim 1, wherein said intake runner includes:

an inclined surface with a semi-circular cross section; and

a straight surface with the shape of an interior surface of a segmented cylinder.

3. A cylinder head assembly according to claim 1, wherein said runner filler has a contact surface with the shape of an exterior surface of a segmented cylinder.

4. A cylinder head assembly according to claim 1, wherein said intake passageway is formed by said section and said runner filler.

5. A cylinder head assembly according to claim 1, wherein said entrance is elliptical in shape.

6. A cylinder head assembly according to claim 1, wherein said entrance has a eight dimension and a width dimension, said height dimension being greater than said width dimension.

7. A cylinder head assembly according to claim 6, wherein a line including said height dimension is substantially transverse to a longitudinal axis of a piston cylinder.

8. A cylinder head assembly according to claim 6, wherein a line including said height dimension is substantially parallel to a longitudinal axis of a piston cylinder.

9. A cylinder head assembly according to claim 1, wherein said entrance is substantially circular in shape.

10. A cylinder head assembly according to claim 1, wherein said entrance has a height dimension and a width dimension, said height dimension being substantially the same as said width dimension.

11. A cylinder head assembly according to claim 1, wherein said cylinder head assembly includes a cylinder head, and said adapter thermally insulates a carburetor from said cylinder head.

12. A cylinder head assembly according to claim 11, wherein said adapter has a spacer that thermally insulates a carburetor from said cylinder head.

13. A cylinder head assembly according to claim 1, wherein said adapter has a substantially cylindrical inlet.

14. A cylinder head assembly according to claim 1, wherein said intake passageway has a portion that is completely formed by said runner filler.

15. A cylinder head assembly for an internal combustion engine comprising:

an intake port;

an intake runner that receives at least one of air and fuel, said intake runner including:

an entrance;

a section having a first end nearer said entrance and having a second end nearer said intake port;

an adapter having a runner filler positioned in said intake runner; and

an intake passageway disposed within said intake runner and at least partially defined by said runner filler, wherein the position of said intake passageway is selectable based upon at least one of the position and the configuration of said runner filler.

16. The cylinder head assembly of claim 15, wherein said intake passageway has a substantially uniform cross-sectional area.

17. The cylinder head assembly of claim 15, wherein the cross-sectional area of said intake runner decreases from said entrance to said intake port.

18. The cylinder head assembly of claim 15, wherein said entrance is substantially elliptical in shape.

19. The cylinder head assembly of claim 15, wherein said cylinder head assembly includes a cylinder head, and wherein said adapter thermally insulates a carburetor from said cylinder head.

20. The cylinder head assembly of claim 19, wherein said adapter includes a spacer that thermally insulates said carburetor from said cylinder head.

21. The cylinder head assembly of claim 15, wherein said adapter includes a substantially cylindrical adapter inlet.

22. A cylinder head assembly for an internal combustion engine comprising:

an intake port;

an intake runner that receives at least one of air and fuel, said intake runner including an entrance having a height dimension that is greater than a width dimension of said entrance;

an adapter having an inlet, and having a runner filler positioned in said intake runner; and

an intake passageway at least partially defined by said runner filler, said intake passageway extending from an inlet near said entrance, wherein the position of said inlet is selectable along said height dimension.

23. The cylinder head assembly of claim 22, wherein the cross-sectional area of said intake runner decreases from said entrance to said intake port.

24. The cylinder head assembly of claim 22, wherein said intake passageway has a substantially uniform cross-sectional area.

25. The cylinder head assembly of claim 22, wherein the cross-sectional area of said intake passageway is less than the cross sectional area of said intake runner.

26. The cylinder head assembly of claim 22, wherein the cross-sectional area of said inlet is less than the cross-sectional area of said entrance.

27. The cylinder head assembly of claim 22, wherein said entrance is substantially elliptical in shape.

28. The cylinder head assembly of claim 22, wherein said cylinder head assembly includes a cylinder head, and said adapter thermally insulates a carburetor from said cylinder head.

29. The cylinder head assembly of claim 27, wherein said adapter includes a spacer that thermally insulates said carburetor from said cylinder head.

30. The cylinder head assembly of claim 26, wherein said adapter includes a substantially cylindrical adapter inlet.

31. The cylinder head assembly of claim 22, wherein the position of said intake passageway is selectable based upon at least one of the position and the configuration of said runner filler.

* * * * *